Environmental Effects of Dredging
Technical Notes

INTERIM GUIDANCE FOR PREDICTING QUALITY OF EFFLUENT DISCHARGED
FROM CONFINED DREDGED MATERIAL DISPOSAL AREAS--GENERAL

PURPOSE: The following series of technical notes describe the functions necessary for predicting the quality of effluent discharged from confined dredged material disposal areas during disposal operations.*

EEDP-04-1	General
EEDP-04-2	Test Procedures
EEDP-04-3	Data Analysis
EEDP-04-4	Application

The guidance was developed as a part of on-going research conducted under the Long-Term Effects of Dredging Operations (LEDO) Program. Procedures for such predictions are being refined and verified under LEDO through comparative evaluations of predictions and field measurement of effluent water quality.

BACKGROUND: Confined dredged material disposal has increased because of constraints on open-water disposal. The quality of water discharged from confined disposal areas (effluent) is a major environmental concern associated with such disposal.

A schematic of a typical active confined disposal area is illustrated in Figure 1. Dredged material placed in a disposal area undergoes sedimentation that results in a thickened deposit of material overlaid by clarified water (supernatant), which is discharged as effluent from the site during disposal operations. The concentrations of suspended solids in the effluent can be determined by column settling tests.

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* The modified elutriate test does not account for long-term geochemical changes that may occur following disposal and subsequent drying of the dredged material and therefore should not be used to evaluate quality of surface runoff from the disposal site.
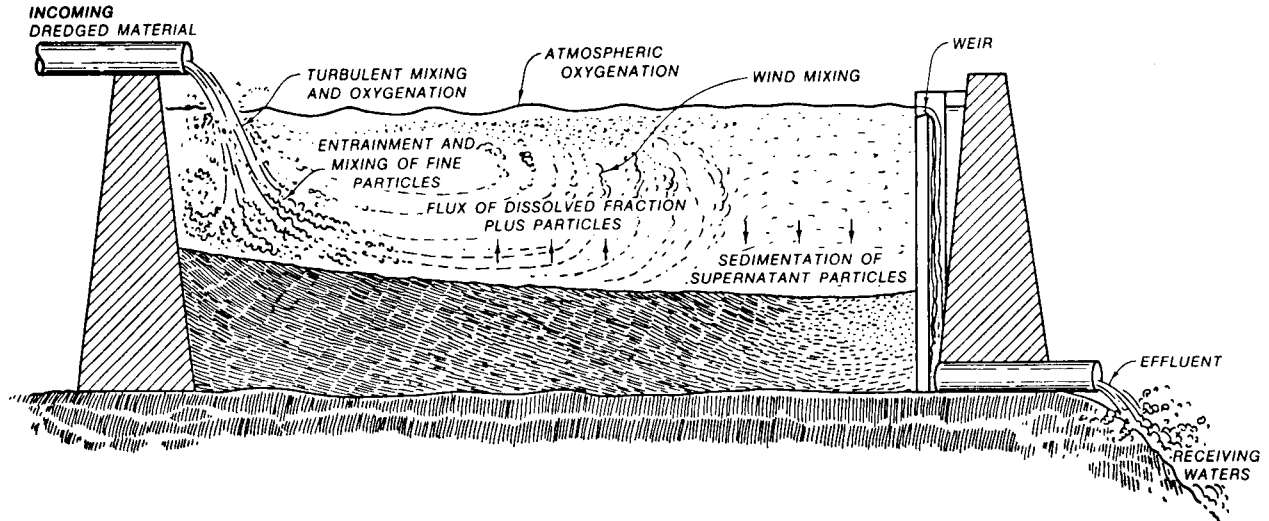
Figure 1. Schematic of factors affecting quality of
effluent from confined disposal areas

The effluent may contain both dissolved and particle-associated contaminants. A large portion of the total contaminant level is particle associated. Results of the standard elutriate test do not reflect the conditions in confined disposal sites that influence contaminant release. A modified elutriate test procedure was therefore developed for use in predicting both the dissolved and particle-associated concentrations of contaminants in the effluent from confined disposal areas. The modified test simulates contaminant release under confined disposal area conditions and reflects the sedimentation behavior of dredged material, retention time of the disposal area, and chemical environment in ponded water during disposal.

REGULATORY ASPECTS: Guidelines have been published to reflect the 1977 Amendments of Section 404 of the Clean Water Act (EPA 1980a). Proposed testing requirements define dredged material according to the four categories shown in Figure 2 (EPA 1980b). Category 3 includes potentially contaminated material proposed for confined disposal that has "potential for contamination of the receiving water column only." The proposed testing requirements call for evaluation of short-term water column impacts of disposal area effluents. Predicted contaminant levels based on results of modified elutriate and column settling tests along with operational considerations can be used with appropriate water-quality standards to determine the mixing zone required to dilute the effluent to an acceptable level (Environmental Effects Laboratory 1976, EPA/CE 1977).

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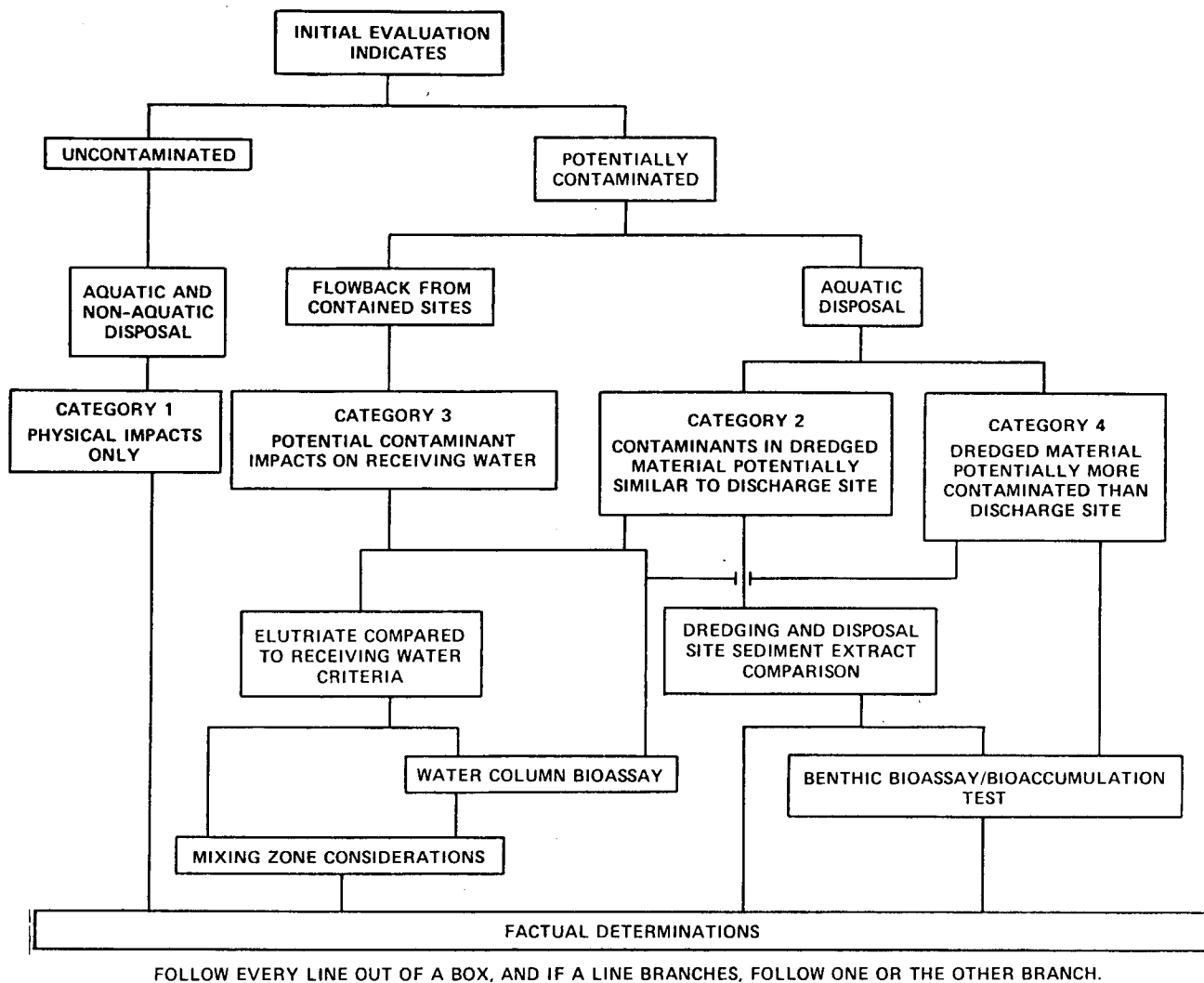
FOLLOW EVERY LINE OUT OF A BOX, AND IF A LINE BRANCHES, FOLLOW ONE OR THE OTHER BRANCH.

Figure 2. Proposed dredged material regulatory testing flow chart (EPA 1980b)

Predictive Technique

The prediction of the quality of effluent from confined dredged material disposal areas must account for both the dissolved concentrations of contaminants and that fraction in the total suspended solids. A modified elutriate test procedure, developed for this purpose, defines dissolved concentrations of contaminants and contaminant fractions in the total suspended solids under quiescent settling conditions and accounts for the geochemical changes occurring in the disposal area during active disposal operations. Column settling test procedures (Montgomery 1978; Palermo, Montgomery, Poindexter 1978) were refined and extended to define the concentration of suspended solids in the effluent for given operational conditions

(i.e., surface area, ponding depth, inflow rate, and hydraulic efficiency).

Using results from both of these tests, a prediction of the total concentration of contaminants in the effluent can be made. A flow chart illustrating the technique is shown in Figure 3. The procedures for conducting both tests are given in Technical Note EEDP-04-2.
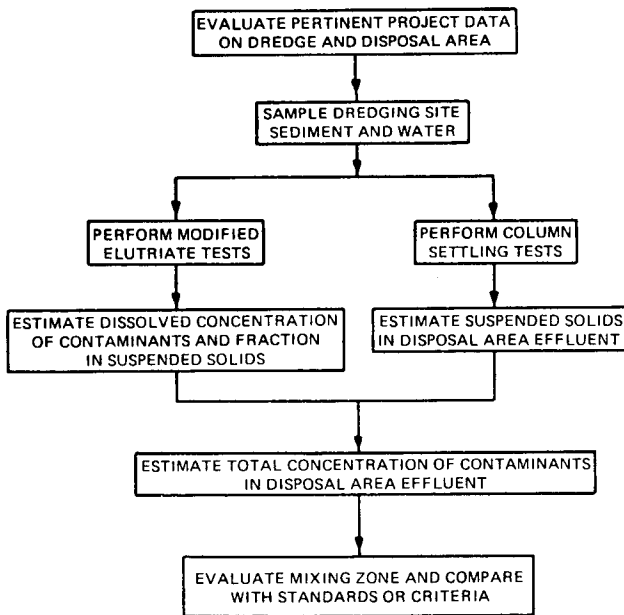
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        │ EVALUATE PERTINENT PROJECT DATA │
        │   ON DREDGE AND DISPOSAL AREA   │
        └─────────────────────────────┘
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        ┌─────────────────────────┐
        │    SAMPLE DREDGING SITE     │
        │    SEDIMENT AND WATER       │
        └─────────────────────────┘
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        ┌─────────────┴─────────────┐
        │                           │
┌───────────────┐         ┌──────────────────┐
│ PERFORM MODIFIED │       │  PERFORM COLUMN    │
│ ELUTRIATE TESTS  │       │  SETTLING TESTS    │
└───────────────┘         └──────────────────┘
        │                           │
┌──────────────────────────┐ ┌──────────────────────┐
│ ESTIMATE DISSOLVED CONCENTRATION │ │ ESTIMATE SUSPENDED SOLIDS │
│ OF CONTAMINANTS AND FRACTION     │ │ IN DISPOSAL AREA EFFLUENT │
│   IN SUSPENDED SOLIDS            │ └──────────────────────┘
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   │ ESTIMATE TOTAL CONCENTRATION OF CONTAMINANTS │
   │        IN DISPOSAL AREA EFFLUENT            │
   └───────────────────────────────────────────┘
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   ┌───────────────────────────────────┐
   │ EVALUATE MIXING ZONE AND COMPARE   │
   │   WITH STANDARDS OR CRITERIA       │
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Figure 3. Steps for predicting effluent water quality

Data Requirements

Data requirements for prediction of effluent quality include those pertaining to operational considerations (i.e., disposal site characteristics and dredge characteristics) and those pertaining to the properties of the sediment to be dredged (i.e., contaminant-release characteristics and sedimentation characteristics). Data relating to operational considerations are usually determined from the disposal area design and by past experience in dredging and disposal activities for the project under consideration or for similar projects. Data relating to the characteristics of the sediment must be determined from samples of the sediment to be dredged and the dredging site water column.

A summary of the data requirements for effluent quality predictions is given in Table 1. Some of the data can be determined from the design or from evaluation of the site using procedures described by Montgomery (1978) and Palermo, Montgomery, and Poindexter (1978). The remaining data must be developed using the procedures described in Technical Note EEDP-04-2.

Sampling Requirements

Samples of sediment and water from a proposed dredging site are required for characterizing the sediment to be dredged and for conducting modified elutriate tests and column settling tests. The level of effort, including the

Table 1

Data Requirements for Predicting the Quality of Effluent
from Confined Dredged Material Disposal Area*

Data Required	Symbol	Source of data
Dredge inflow rate	Q_i	Project information, site design
Dredge inflow solids concentration	C_i	Project information, site design
Ponded area in disposal site	A_p	Project information, site design
Average ponding depth in disposal site and at the weir	D_p, D_{pw}	Project information, site design
Hydraulic efficiency factor	HEF	Dye tracer or theoretical determination
Effluent total suspended solids concentration	SS_{eff}	Column settling tests
Dissolved concentration of contaminant in effluent	C_{diss}	Modified elutriate tests
Fraction of contaminant in the total suspended solids in effluent	F_{SS}	Modified elutriate tests

* This summary includes only those data required for effluent quality pre-
diction. It was assumed that the disposal area under consideration was
designed for effective sedimentation and storage capacity. Data require-
ments for design or evaluation of a disposal area are found in Palermo,
Montgomery, and Poindexter (1978).

number of sampling stations, quantity of material, and any scheme used for
compositing samples, is highly project specific. If at all possible, the
sampling operations required for sediment characterization (both physical and
chemical), for design or evaluation of the disposal site, and for modified
elutriate and column settling tests should be conducted simultaneously to
avoid duplication of effort and to ensure sample similarity.

Normally effluent quality will be of concern for maintenance dredged
material. Representative samples of sediments proposed for maintenance
dredging are satisfactory for obtaining the quantities needed for all testing
requirements. General guidance on sampling for chemical characterization
purposes is found in Plumb (1981). This reference should be used for guidance
in obtaining samples for use in the modified elutriate testing.

Application

The technique for predicting the quality of effluent discharged from confined dredged material disposal areas is described in Technical Note EEDP-04-3. The technique can be applied to predict the performance of existing sites or to design new sites.

For existing sites, the technique can be used to predict effluent quality for a given set of anticipated operational conditions (known flow and ponding conditions). In a similar manner, the procedure can be used to determine the operational conditions (size, geometry, maximum allowable dredge size, etc.) for a proposed site to meet a given effluent quality requirement. Examples of both of these cases are presented in Technical Note EEDP-04-4.

References

Environmental Effects Laboratory. 1976. "Ecological Evaluation of Proposed Discharges of Dredged Material into Navigable Water," Miscellaneous Paper D-76-17, US Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.Environmental Protection Agency. 1980a. "Guidelines for Specification of Disposal Sites for Dredged or Fill Material," Federal Register, Vol.45, No. 249, pp 85336-85358.

Environmental Protection Agency. 1980b. "Testing Requirements for the Specification of Disposal Sites for Dredged or Fill Material," Federal Register, Vol. 45, No. 249, pp 85359-85367.

Environmental Protection Agency/Corps of Engineers. 1977. "Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Water, Implementation Manual for Section 103 of Public Law 95-532 (Marine Protection, Research, and Sanctuaries Act of 1972)," US Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Montgomery, R. L. 1978. "Methodology for Design of Fine-Grained Dredged Material Containment Areas for Solids Retention," Technical Report D-78-56, US Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Palermo, M. R., Montgomery, R. L., and Poindexter, M. 1978. "Guidelines for Designing, Operating, and Managing Dredged Material Containment Areas," Technical Report DS-78-10, US Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Plumb, R. H. 1981. "Procedures for Handling and Chemical Analysis of Sediment and Water Samples," EPA/CE Technical Committee on Criteria for Dredged and Fill Material, US Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Notations

The notations used in Technical Notes EEDP-04-1 through 4 are defined as follows.

A_p	Area ponded, acres
C_{diss}	Dissolved concentration of constituent, milligrams per liter
C_i	Inflow solids concentration, grams per liter
C_{slurry}	Solids concentration of slurry, grams per liter (dry weight basis)
$C_{sediment}$	Solids concentration of sediment, grams per liter (dry weight basis)
C_{total}	Total concentration of constituent, milligrams per liter
F_{SS}	Fraction of constituent in total suspended solids, milligrams per kilogram
D_p	Depth of ponding in disposal site, ft
D_{pw}	Desired ponding depth or ponding depth at weir, ft
HEF	Hydraulic efficiency factor
Q_i	Inflow rate, cubic feet per second
P	Percent of suspended solids remaining at test interval
R	Percent of solids removed from suspension at test interval
RF	Resuspension factor
SS	Total suspended solids concentration, milligrams per liter
SS_{col}	Suspended solids concentration determined by column test, milligrams per liter
SS_{eff}	Suspended solids concentration of effluent considering anticipated resuspension, milligrams per liter of water
T	Theoretical detention time, hours
T_d	Field mean detention time, hours
t	Sampling time, hr
$V_{sediment}$	Volume of sediment, liters
V_p	Volume ponded, acre-feet
V_{water}	Volume of water, liters
z	Sample depth, feet
ϕ	Percent of initial suspended solids concentration (beginning of column settling test used as 100 percent)